Evaluating District Energy Systems – Central vs. Decentral Storages in Dynamic Electricity Pricing

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Energy | 12th April 2024

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FCN | Future Energy Consumer Needs and Behavior

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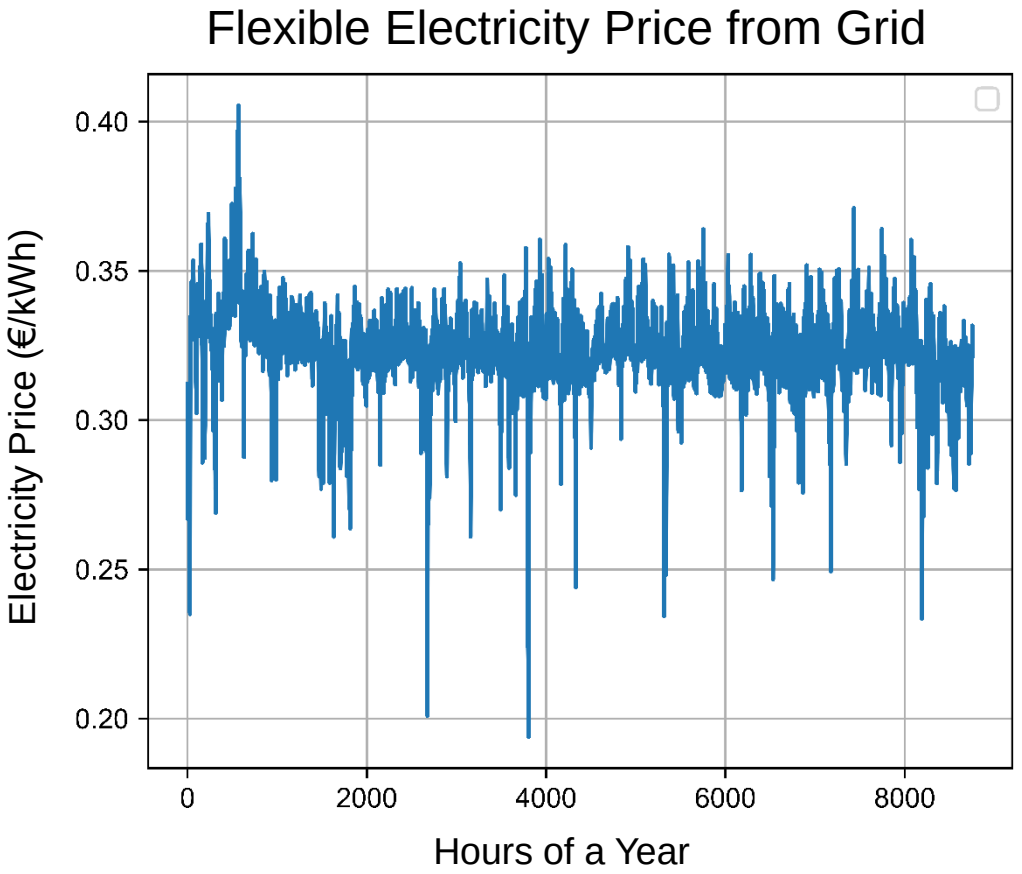
Introduction

- Ongoing expansion of renewable energies: significance of **flexibility** in the energy system increasing
- Past/Status Quo: supply following demand
- Future: **demand increasingly aligning itself** with the available supply
- Adjustments can be stimulated by flexible electricity prices and **facilitated by additional flexibilities**, such as battery and thermal storage

Research Question:

Which is more cost-effective in districts under flexible electricity pricing: centralized or decentralized storage?



Note: The electricity price time series is based on data from the German electricity exchange. The trading prices were scaled so that they correspond to an average of € 0.3216.

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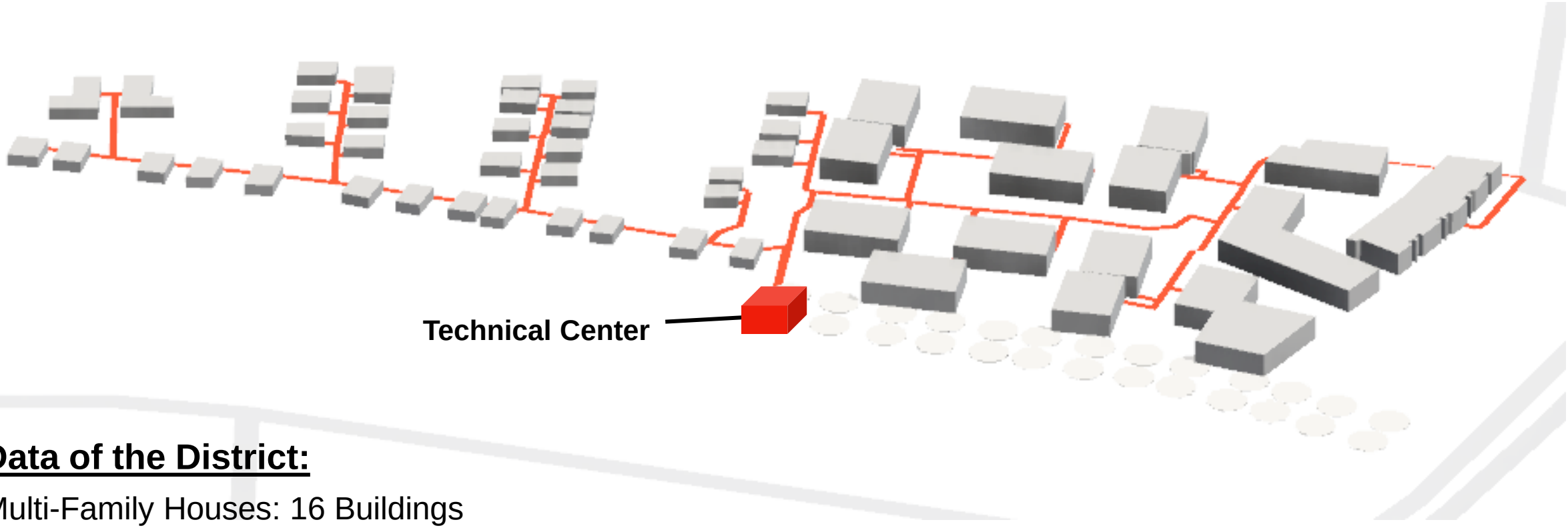
Case study: District “Stadtteilpark Hassel“



Data of the District:

Multi-Family Houses: 16 Buildings

Single-Family Houses: 34 Buildings

No. of Apartments: 200

Inhabitants: ~500

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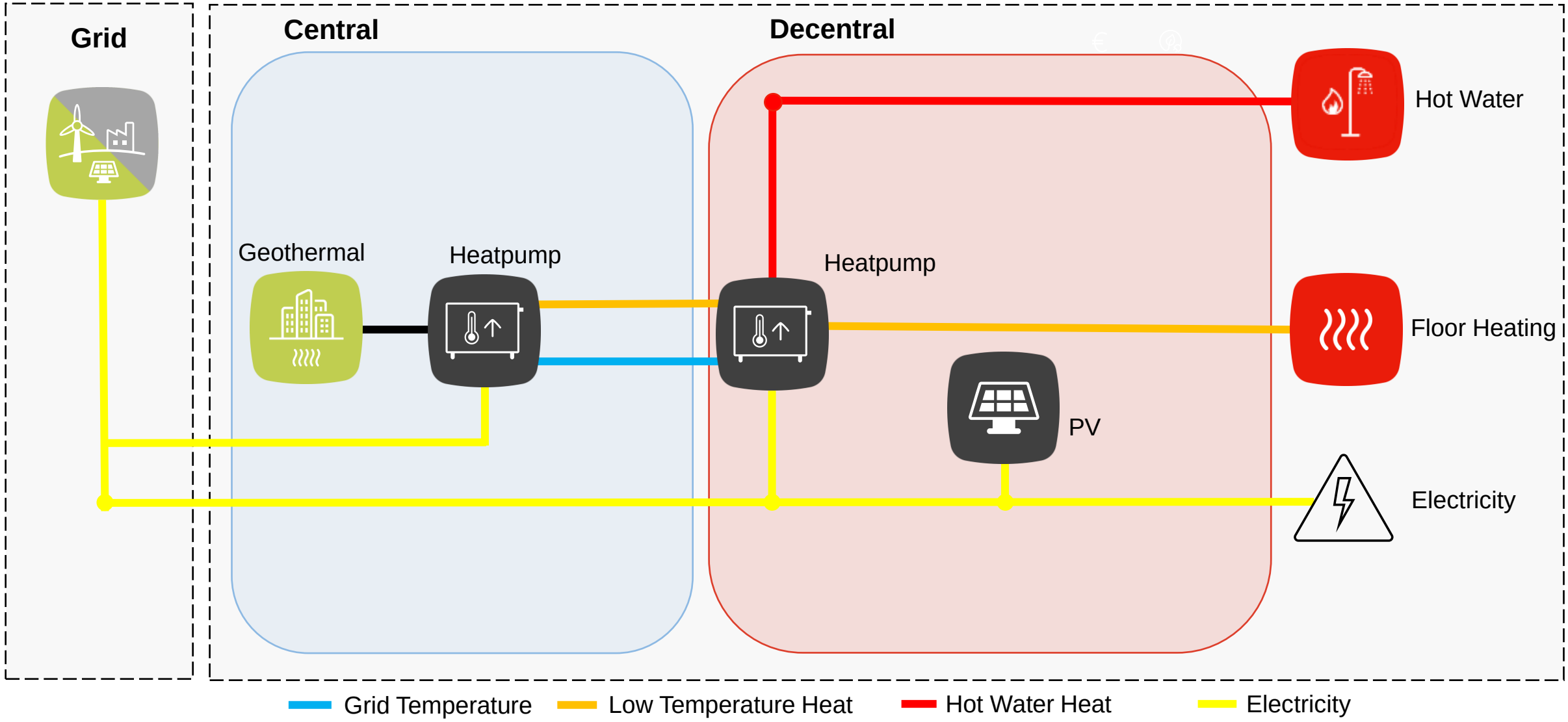
Energy System Model: No Storage



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Energy System Model: Central Storage

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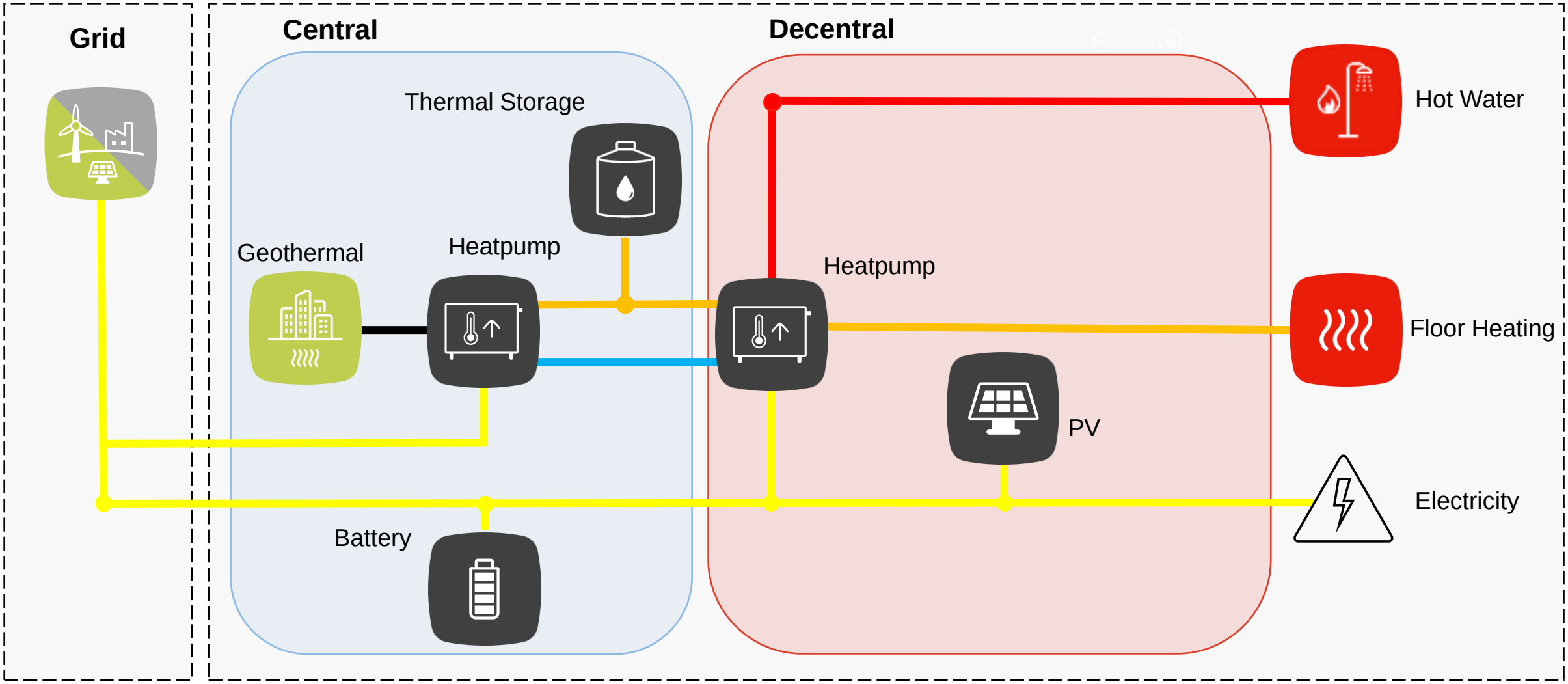

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Energy System Model: Decentral Storage

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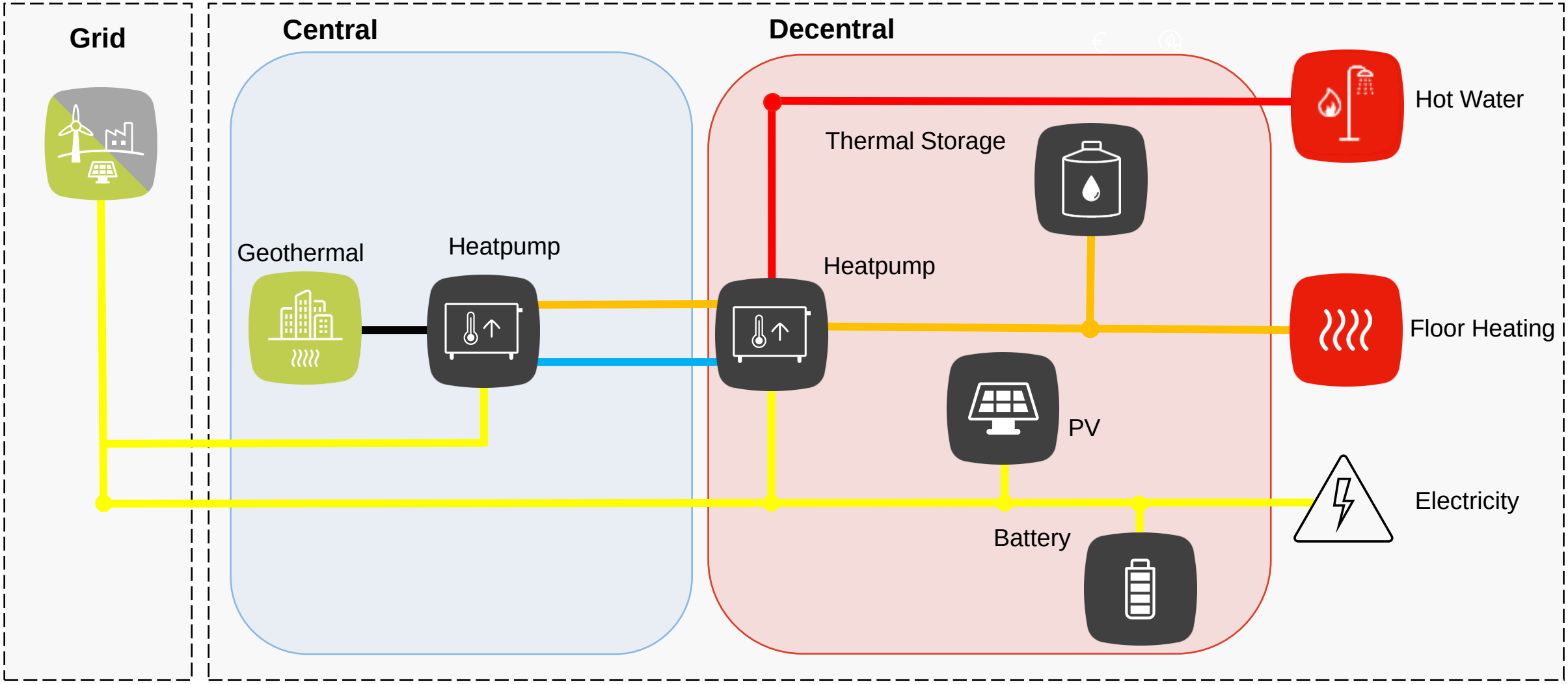

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Table 1: Cost Data for Storage

	Battery	Thermal Storage
CAPEX (€/kW)	301	300
Efficiency Charge (%)	95	99
Efficiency Discharge (%)	95	99
Self Discharge (%)	0.006	0.25

Table 2: Cost Data for Technologies

	PV	Heatpump Water Water	Heatpump Geothermal
CAPEX (€/kW)	1531.91	1526.16	1526.16
CAPEX (€)	882.35	2163.78	2163.78
OPEX (€/kW)	38.3	38.15	38.15
OPEX (€)	22.06	54.09	54.09

Note: All data was computed and/or simulated within the TransUrban.NRW project.

Figure 1: Electricity Demand

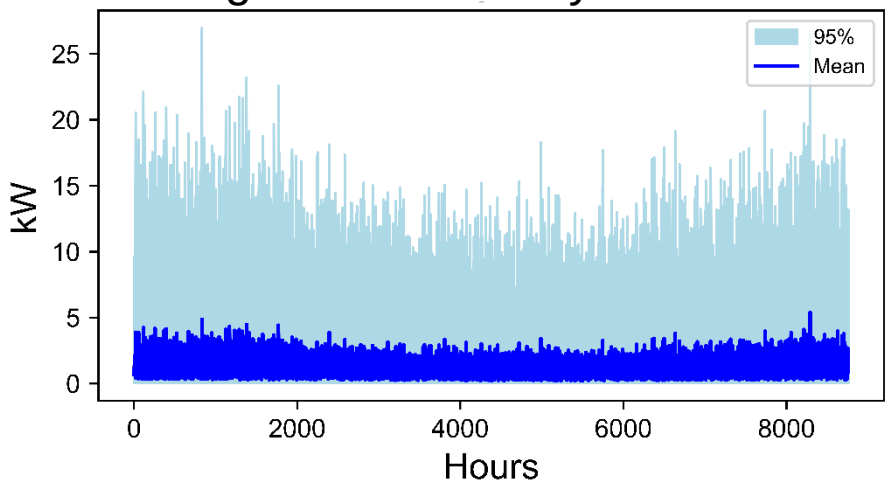
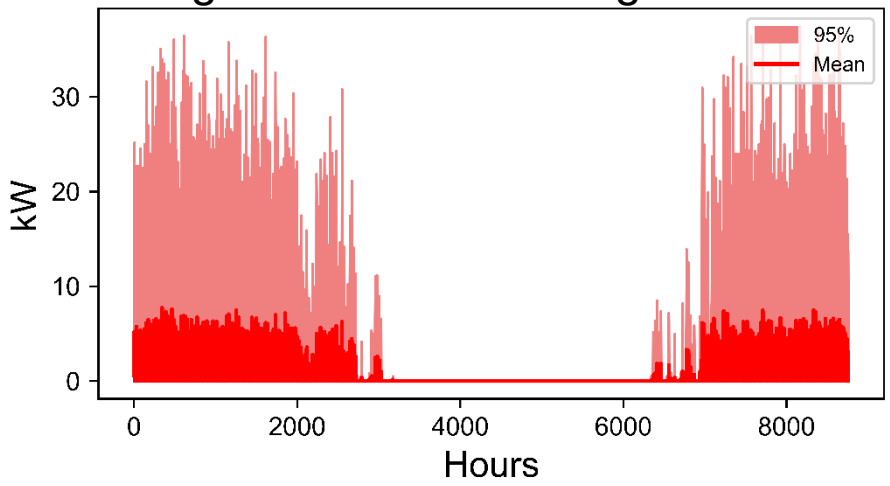


Figure 2: Floor Heating Demand



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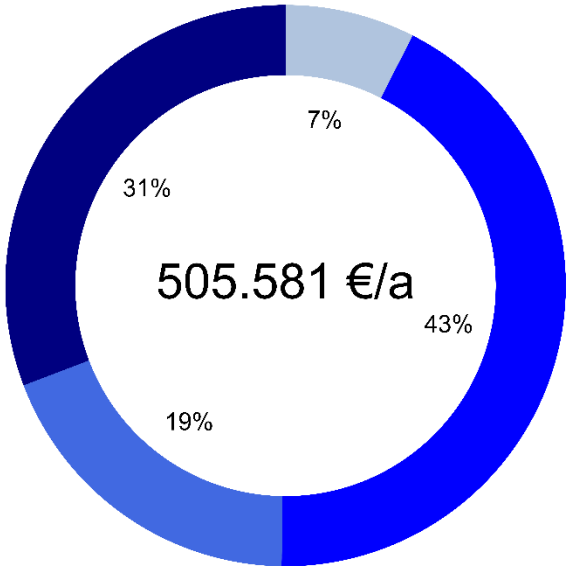
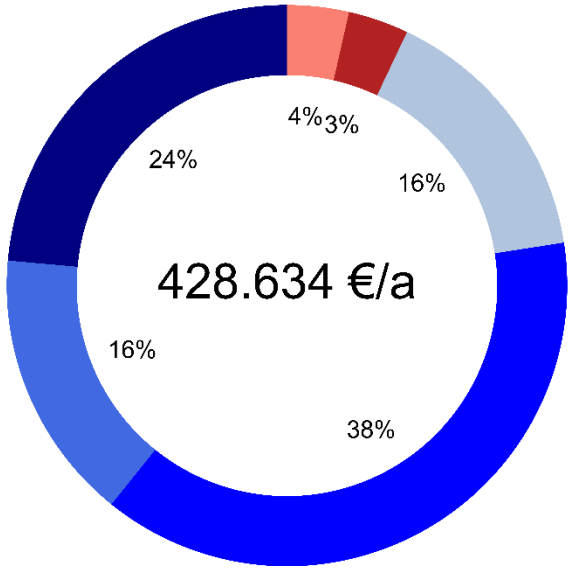
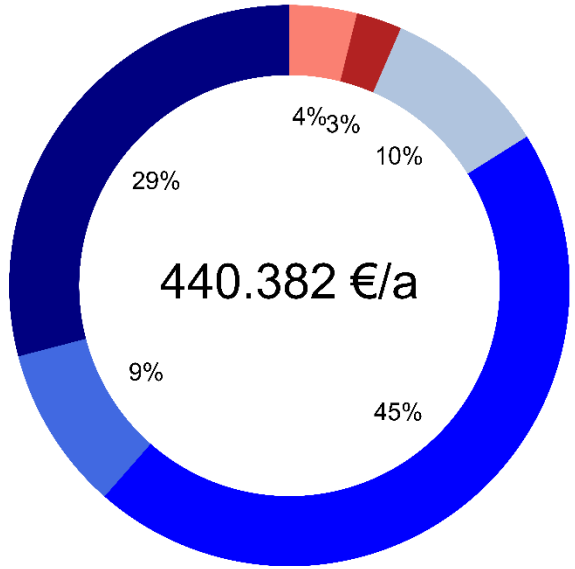
No Storage

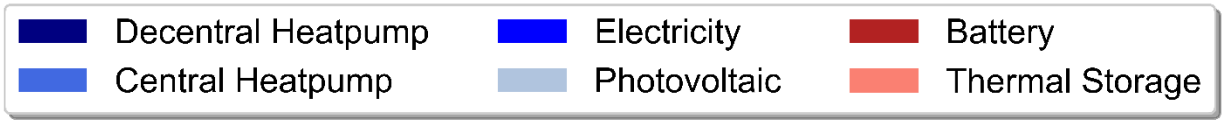


Central Storage



Decentral Storage





Note: Own calculations.

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Table 3: Cost Comparison of the Different Storage Specifications

Cost (€)	No Storage	Central Storage	Decentral Storage
Electricity Expenditure	**253,885**	**230,301**	**242,041**
Electricity from Grid	216,006	163,851	199,864
PV	37,879	66,450	42,177
Heat Expenditure	**251,694**	**168,132**	**169,673**
Central Heatpumps	96,055	67,081	41,700
Decentral Heatpumps	155,639	101,051	127,973
Storage Expenditure	**-**	**30,198**	**28,662**
Battery	-	14,964	11,573
Thermal Storage	-	15,234	17,089

Note: Own calculations.

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Conclusion

- Centralized and decentralized storage more cost-efficient than not using any form of storage
- District “Stadtteilpark Hassel“: **centralized storage dominates** over decentralized storage
- Regulation prevents more efficient use
- Under decentralized storage, PV electricity can support the use of thermal storage

Outlook

- Examination of the utilization of centralized and decentralized storages and their influence on grid electricity consumption remains incomplete
- Varying peaks in electricity demand from the grid significantly affect distribution grids and present new opportunities for revenue generation, such as reduced grid charges
- Investigation into the disparities in participation in **balancing the electricity market** between districts employing centralized versus decentralized electrical storage systems is warranted

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Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages

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Thank you for your attention!

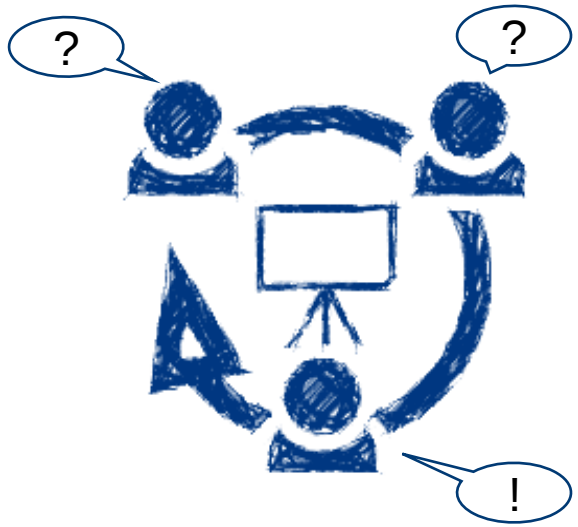

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Table 3: Comparison of the Different Storage Specifications

	No Storage	Central Storage	Decentral Storage
Battery (€)	-	14,979	11,573
Thermal Storage (€)	-	27,910	17,089
PV (€)	37,879	66,843	42,178
Autarchy (%)	20.87	40.68	29.28
Self Consumption (%)	66.89	81.70	100

Note: Own calculations.

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